



The Multiverse: Who's Afraid?

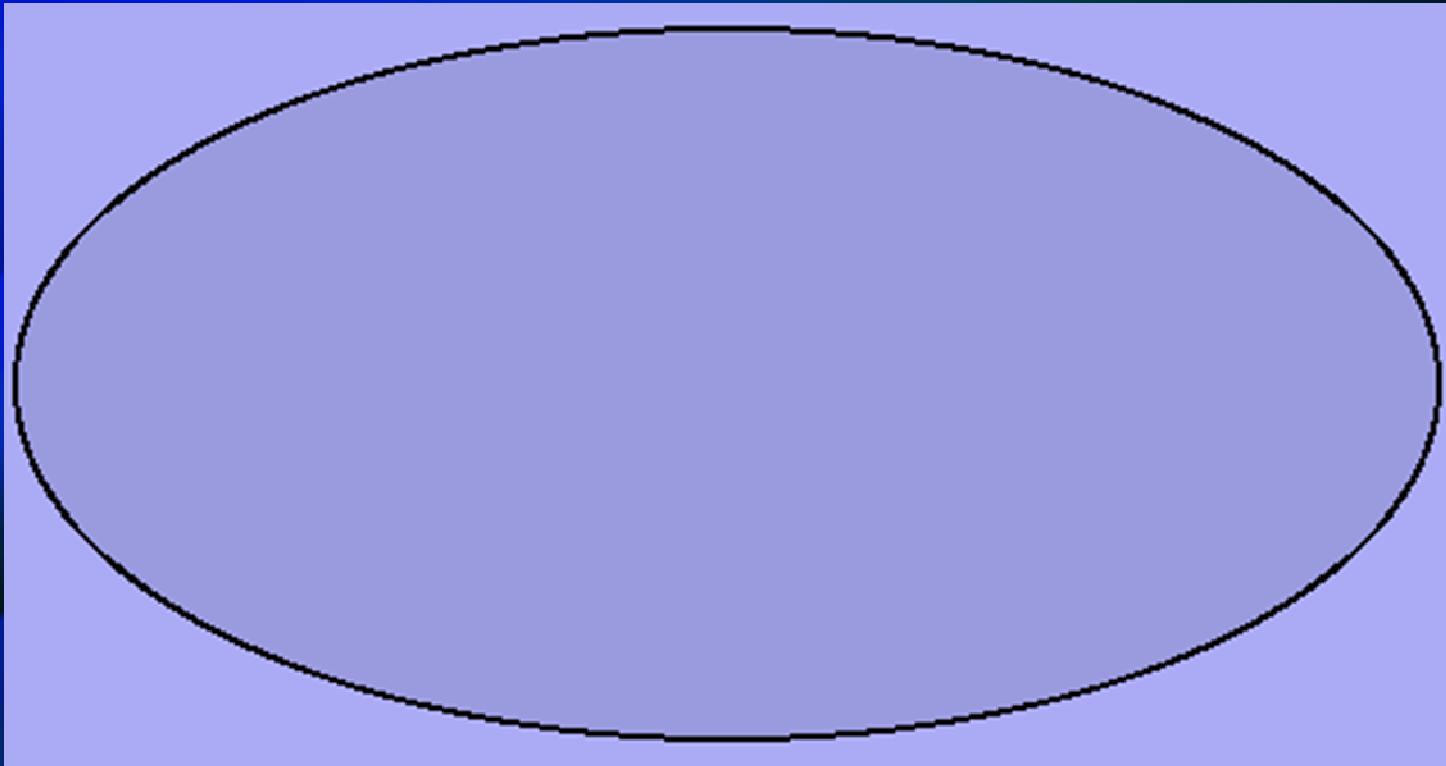
Jeff Zweerink
Huntsville Chapter
5 November 2009

Major Discoveries



Edwin Hubble Discovers the Expansion of
the Universe in 1929

Major Discoveries



Arno Penzias and Robert Wilson Discover
the Cosmic Microwave Background
Radiation in 1965 (Nobel Prize, 1978)

Major Discoveries

Proc. Roy. Soc. Lond. A. 314, 529-548 (1970)

Printed in Great Britain

The singularities of gravitational collapse and cosmology

BY S. W. HAWKING

Institute of Theoretical Astronomy, University of Cambridge

AND R. PENROSE

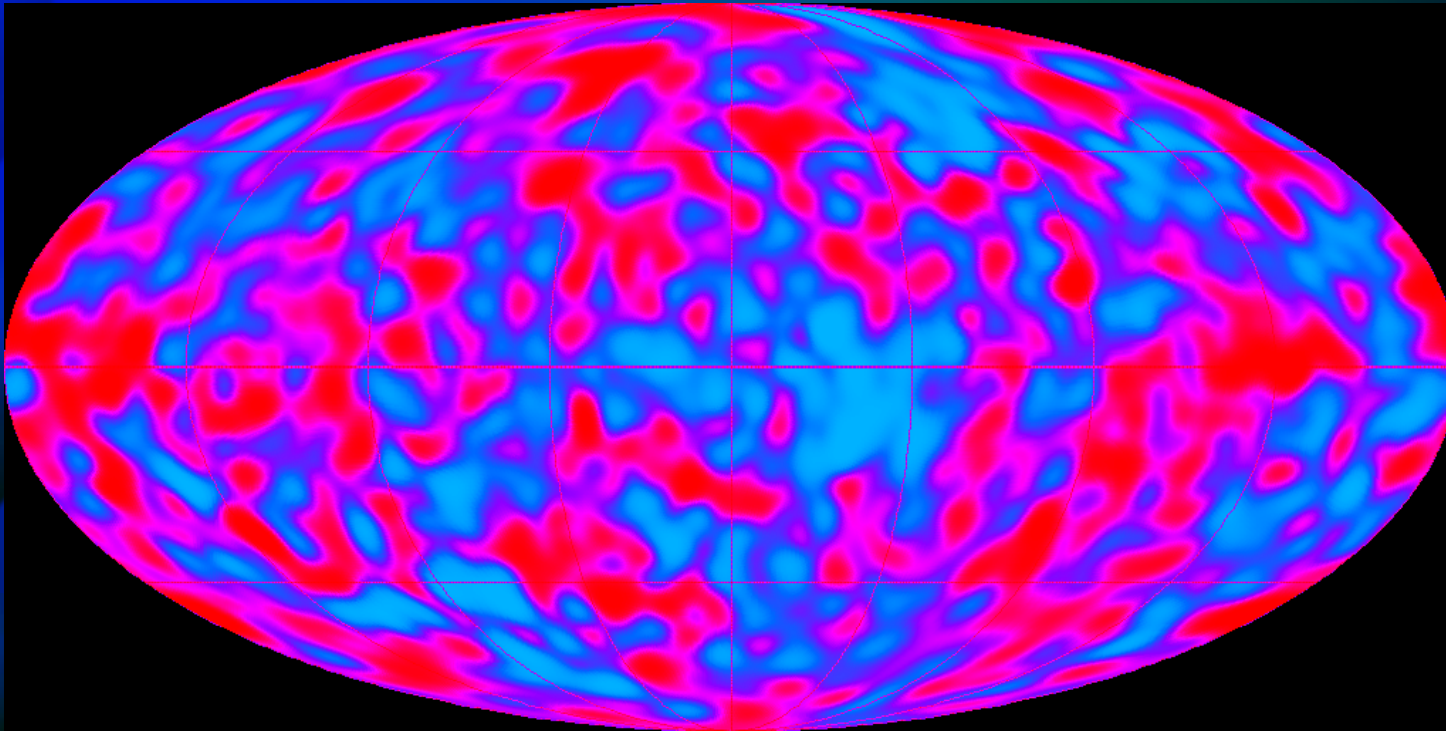
Department of Mathematics, Birkbeck College, London

(Communicated by H. Bondi, F.R.S.—Received 30 April 1969)

A new theorem on space-time singularities is presented which largely incorporates and generalizes the previously known results. The theorem implies that space-time singularities are to be expected if *either* the universe is spatially closed *or* there is an 'object' undergoing relativistic gravitational collapse (existence of a trapped surface) *or* there is a point p whose past null cone encounters sufficient matter that the divergence of the null rays through p changes sign somewhere to the past of p (i.e. there is a minimum apparent solid angle, as viewed from p for small objects of given size). The theorem applies if the following four physical assumptions are made: (i) Einstein's equations hold (with zero or negative cosmological constant), (ii) the energy density is nowhere less than minus each principal pressure nor less than minus the sum of the three principal pressures (the 'energy condition'), (iii) there are no closed timelike curves, (iv) every timelike or null geodesic enters a region where the curvature is not specially aligned with the geodesic. (This last condition would hold in any sufficiently general physically realistic model.) In common with earlier results, timelike or null geodesic incompleteness is used here as the indication of the presence of space-time singularities. No assumption concerning existence of a global Cauchy hypersurface is required for the present theorem.

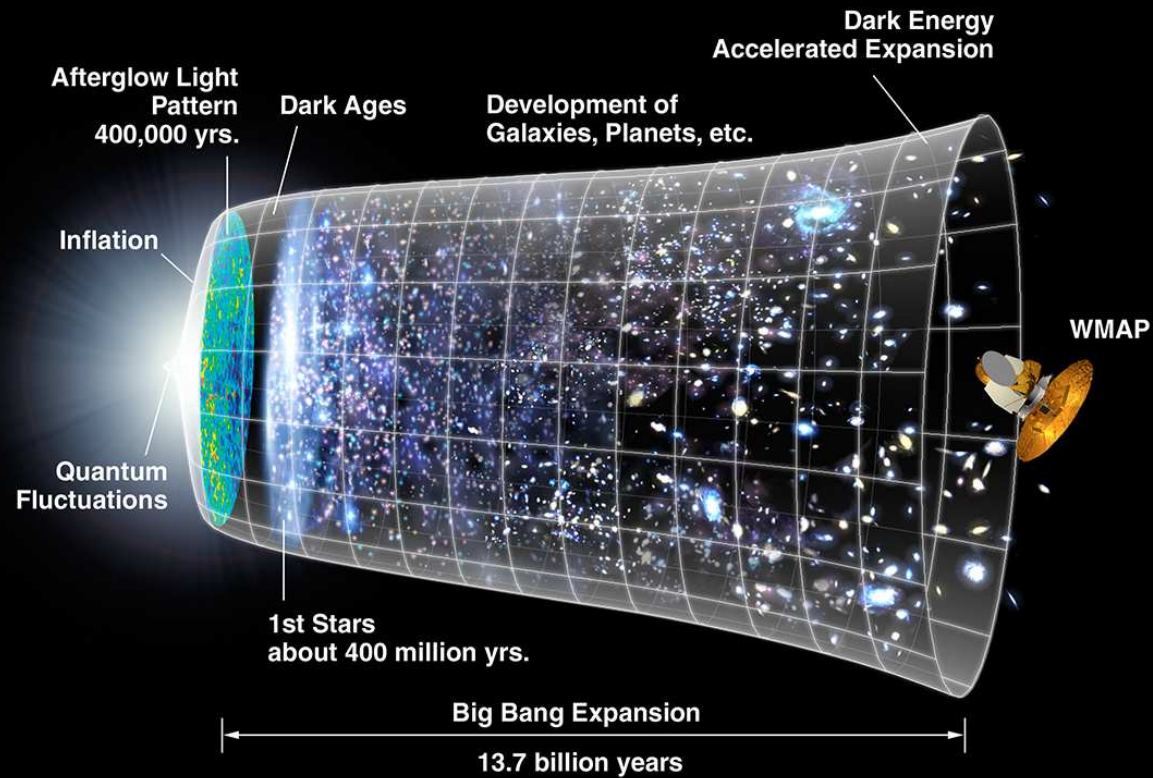
Stephen Hawking and Roger Penrose
Establish that the Universe Began to
Exist in 1970

Major Discoveries

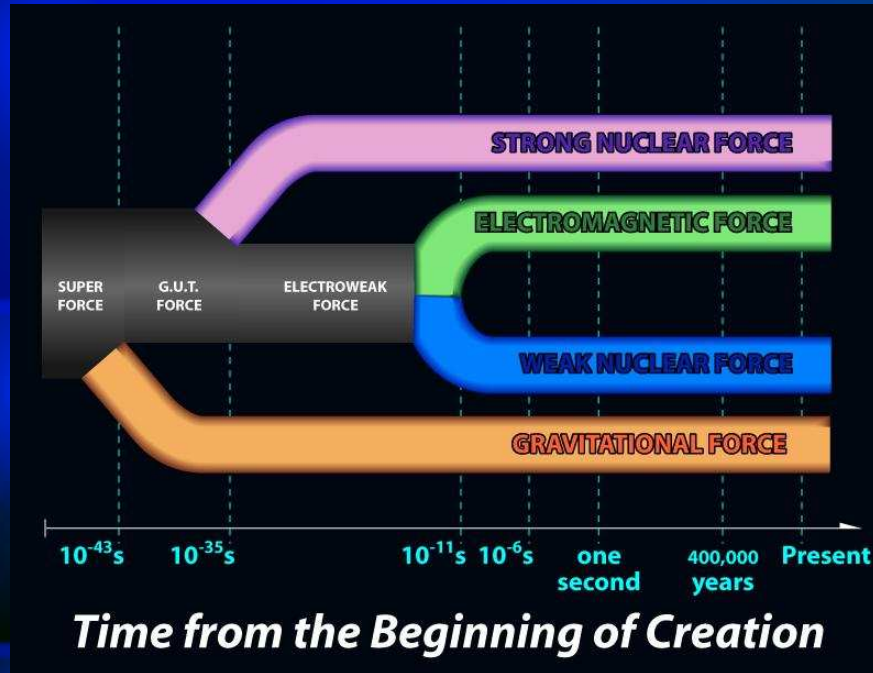


COBE Satellite Finds Ripples in the CMB
Radiation (Nobel Prize, 2006)

Overview of Universe

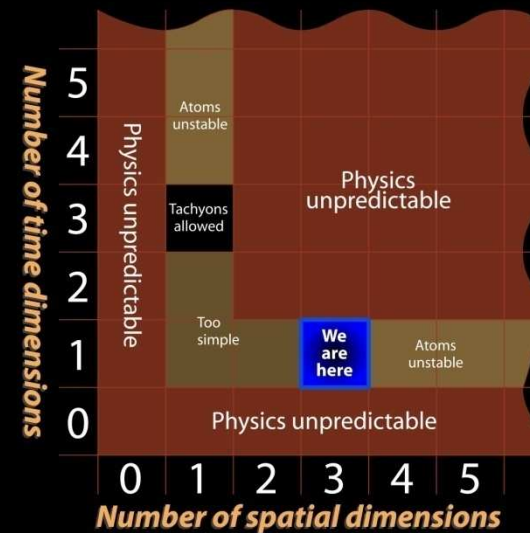


Design of Universe

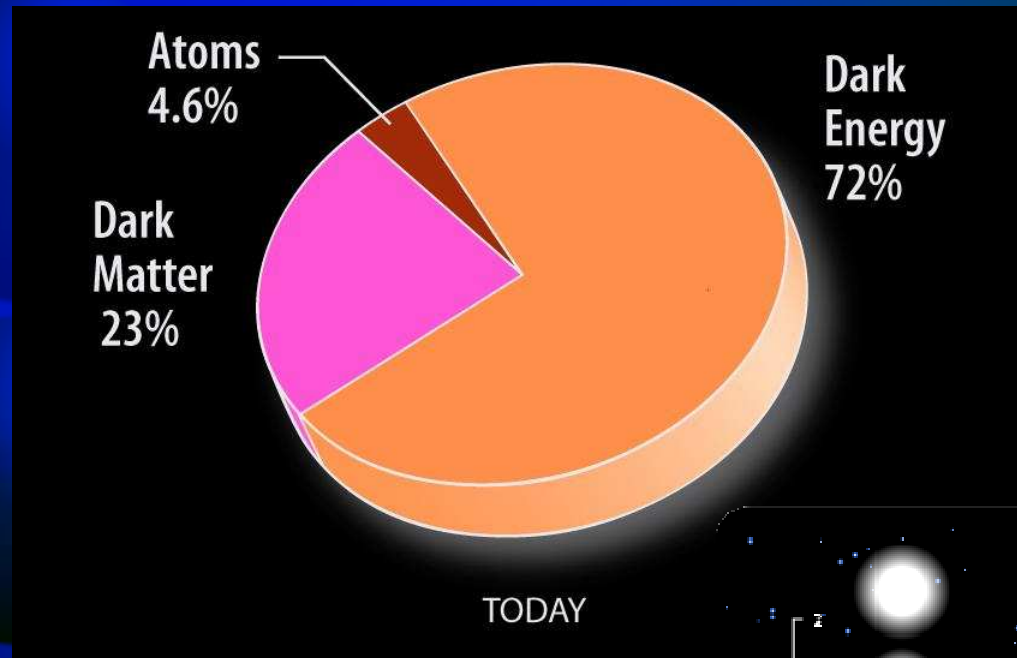


Strengths and Types of Forces

Number and Size of Space and Time Dimensions

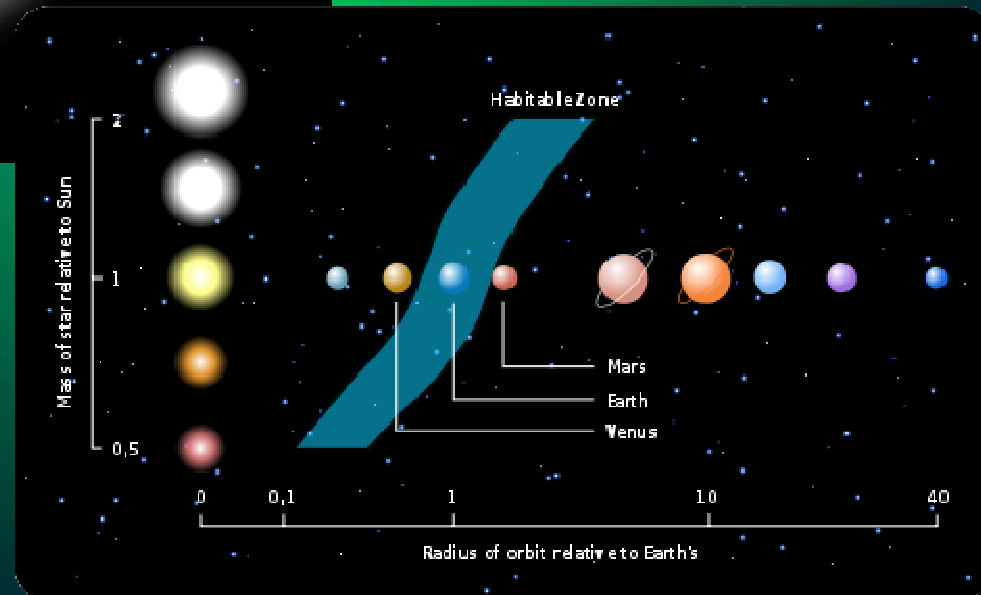


Design of Universe



Composition of Universe

Environment of Earth



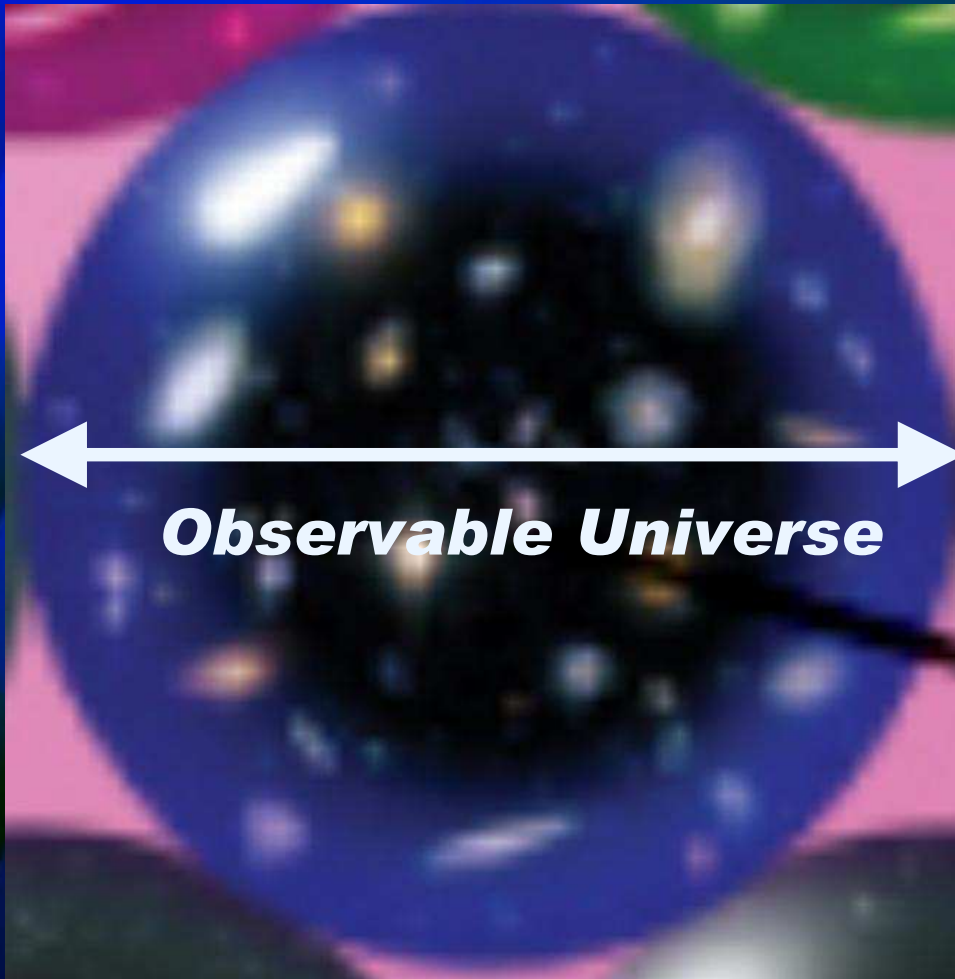
One second

~2 million years

~12 billion years



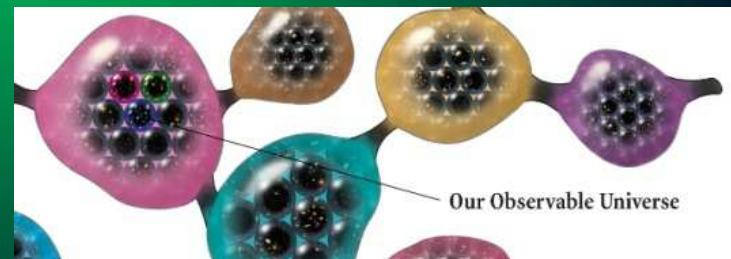
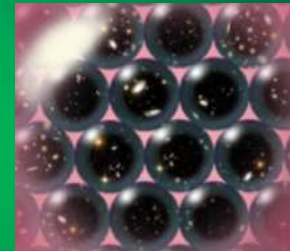
What Is the Multiverse?



What is the Multiverse?

Physical realms beyond the observable universe

- Level I
Different Hubble volumes
Far away in space
- Level II
Different universes
Infinitely far away in space



Naturalistic Requirements

- Self-contained \Rightarrow
 No beginning, No design
- Must explain observable universe and make testable predictions
- Must produce sufficient variety
- Our universe must be one of the possible outcomes
- Life must be completely physical

Cosmological Argument

- Our observable universe still begins at the big bang
- Level II says that the beginning of our universe is nothing unique
 - Maybe multiverse existed forever

Cosmological Argument

- However, even the multiverse must have a beginning.

VOLUME 90, NUMBER 15

PHYSICAL REVIEW LETTERS

week ending
18 APRIL 2003

Inflationary Spacetimes Are Incomplete in Past Directions

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(Received 5 October 2001; revised manuscript received 24 January 2003; published 15 April 2003)

Many inflating spacetimes are likely to violate the weak energy condition, a key assumption of singularity theorems. Here we offer a simple kinematical argument, requiring no energy condition, that a cosmological model which is inflating—or just expanding sufficiently fast—must be incomplete in null and timelike past directions. Specifically, we obtain a bound on the integral of the Hubble parameter over a past-directed timelike or null geodesic. Thus inflationary models require physics other than inflation to describe the past boundary of the inflating region of spacetime.

Teleological Argument

- “Environmental” fine-tuning:
 - size of multiverse
- “Fundamental” fine-tuning:
 - number of universes in multiverse
- Assumes all life is purely physical
- But there are difficulties . . .

Problems for Naturalists

- Universe: Are we rare?
- Multiverse: Are we typical?
- If life is purely physical, life abounds in the multiverse . . .
 - Boltzmann Brains
 - The Matrix
 - Identity, free-will, justice....
- What role for science?

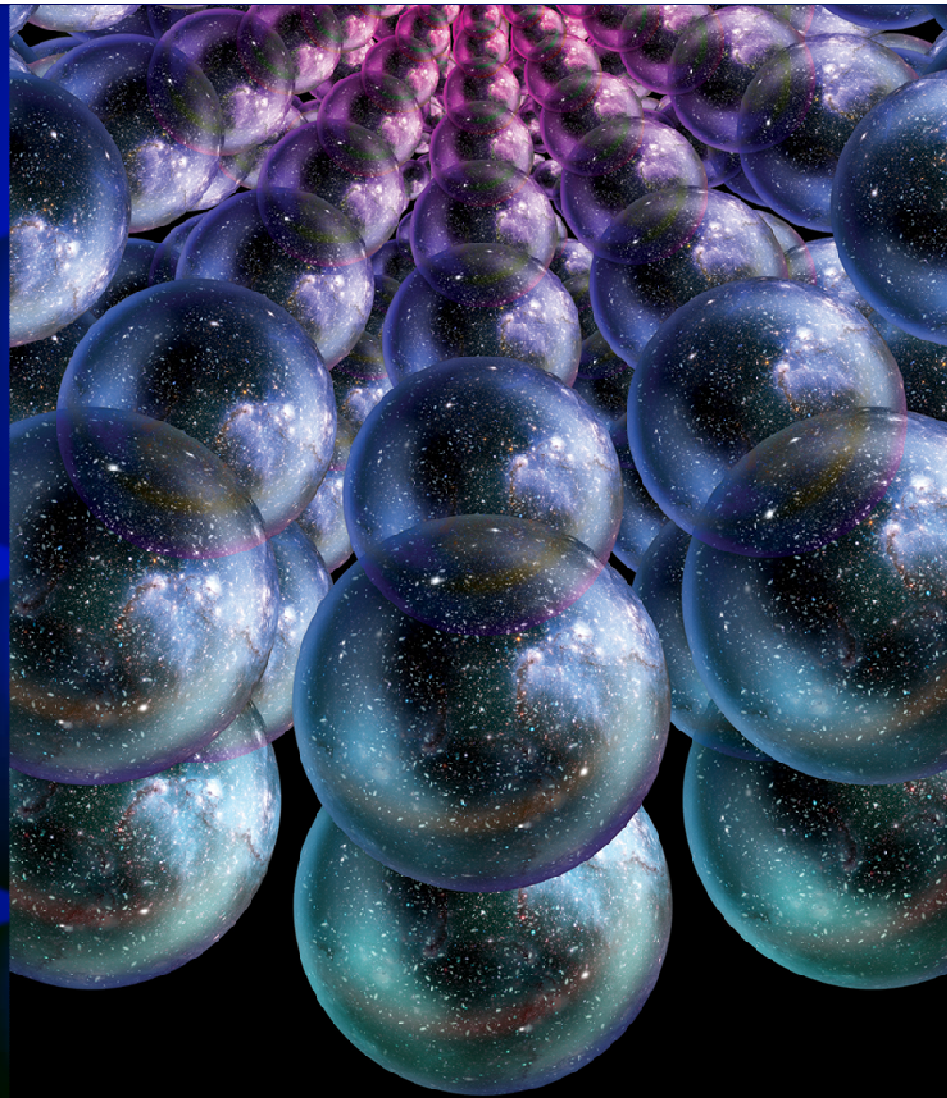
The Christian Multiverse?

- Bible describes at least one other physical realm – the new creation
- God's economy may not match ours
 - Billion trillion stars, trillions of galaxies
- Christian worldview “solves” the problems that plague naturalistic multiverse models

Who's Afraid?

- Multiverse research strengthens cosmological, teleological arguments
- Raises difficult problems in a naturalistic worldview
- Christian worldview resolves those issues

As Christian's we have nothing to fear from the multiverse



WHO'S AFRAID OF THE
MULTIVERSE?

Jeffrey A. Zweerink, Ph.D.

***Who's
Afraid?***